

What is claimed is:

- 1 1. An apparatus comprising:
2 an integrated circuit (IC) die; and
3 a thermal mass coupled to the IC die, wherein the thermal mass comprises a
4 stacked microchannel heat exchanger.
- 1 2. The apparatus of claim 1, wherein the thermal mass is thermally and
2 operatively coupled to the IC die by a layer of solder disposed between the thermal
3 mass and the surface of the IC die.
- 1 3. The apparatus of claim 2, wherein the layer of solder comprises interstitial
2 solder.
- 1 4. The apparatus of claim 1, wherein the thermal mass is thermally and
2 operatively coupled to the IC die by an adhesive disposed between the thermal mass
3 and the surface of the IC die.
- 1 5. The apparatus of claim 4, wherein the adhesive comprises a thermal
2 adhesive.
- 1 6. The apparatus of claim 4, wherein the adhesive comprises a silicon to silicon
2 bonding adhesive.
- 1 7. The apparatus of claim 6, wherein the adhesive comprises a polymer
2 compound.
- 1 8. The apparatus of claim 7, wherein the adhesive comprises
2 bisbenzocyclobutene.

- 1 9. The apparatus of claim 1, wherein the thermal mass is thermally coupled to
2 the IC die by a thermal interface material (TIM) layer.
- 1 10. The apparatus of claim 1, further comprising a substrate to which the IC die
2 is flip-bonded.
- 1 11. The apparatus of claim 10, wherein the thermal mass is operatively coupled
2 to the substrate via a plurality of fasteners.
- 1 12. The apparatus of claim 11, further comprising a plurality of standoffs
2 physically coupled to the substrate and to which the plurality of fasteners are
3 physically coupled
- 1 13. The apparatus of claim 1, further comprising:
2 a solderable layer formed on the IC die; wherein the thermal mass is
3 thermally and operatively coupled to IC die by the solderable layer.
- 1 14. The apparatus of claim 13, wherein the solderable layer is formed from at
2 least one of the following metals: copper (Cu), gold (Au), nickel (Ni), aluminum
3 (Al), titanium (Ti), tantalum (Ta), silver (Ag) and Platinum (Pt).
- 1 15. The apparatus of claim 13, wherein the solderable layer and the thermal
2 mass are made of substantially similar metals.
- 1 16. An apparatus comprising:
2 an integrated circuit (IC) package, said IC package containing one or more
3 IC dies; and
4 a thermal mass coupled to the IC package, wherein the thermal mass
5 comprises a stacked microchannel heat exchanger.

1 17. The apparatus of claim 16, wherein the thermal mass is thermally and
2 operatively coupled to the IC die by a layer of solder disposed between the thermal
3 mass and the surface of the IC die.

1 18. The apparatus of claim 17, wherein the layer of solder comprises interstitial
2 solder.

1 19. The apparatus of claim 16, wherein the thermal mass is thermally and
2 operatively coupled to the IC die by an adhesive disposed between the thermal mass
3 and the surface of the IC die.

1 20. The apparatus of claim 19, wherein the adhesive comprises a thermal
2 adhesive.

1 21. The apparatus of claim 19, wherein the adhesive comprises a silicon to
2 silicon bonding adhesive.

1 22. The apparatus of claim 21, wherein the adhesive comprises a polymer
2 compound.

1 23. The apparatus of claim 22, wherein the adhesive comprises
2 bisbenzocyclobutene.

1 24. The apparatus of claim 16, wherein the thermal mass is thermally coupled to
2 the IC die by a thermal interface material (TIM) layer.

1 25. The apparatus of claim 16, further comprising a substrate to which the IC die
2 is flip-bonded.

- 1 26. The apparatus of claim 25, wherein the thermal mass is operatively coupled
2 to the substrate via a plurality of fasteners.
- 1 27. The apparatus of claim 26, further comprising a plurality of standoffs
2 physically coupled to the substrate and to which the plurality of fasteners are
3 physically coupled
- 1 28. The apparatus of claim 16, further comprising:
2 a solderable layer formed on the IC die; wherein the thermal mass is
3 thermally and operatively coupled to IC die by the solderable layer.
- 1 29. The apparatus of claim 28, wherein the solderable layer is formed from at
2 least one of the following metals: copper (Cu), gold (Au), nickel (Ni), aluminum
3 (Al), titanium (Ti), tantalum (Ta), silver (Ag) and Platinum (Pt).
- 1 30. The apparatus of claim 28, wherein the solderable layer and the thermal
2 mass are made of substantially similar metals.
- 1 31. A system, comprising:
2 an integrated circuit (IC) die;
3 a stacked microchannel heat exchanger operatively and thermally coupled to
4 the IC die;
5 a pump, having an inlet and an outlet, said outlet fluidly coupled to an inlet
6 of the stacked microchannel heat exchanger; and
7 a heat rejecter, having an inlet fluidly coupled to an outlet of the stacked
8 microchannel heat exchanger and an outlet fluidly coupled to the inlet of the pump,
9 wherein the system employs a working fluid that transfers heat generated by the IC
10 die to the heat rejecter using a two-phase heat exchange mechanism.
- 1 32. The system of claim 31, wherein the working fluid is water.

- 1 33. The system of claim 31, wherein the pump comprises an electro osmotic
2 pump.
- 1 34. The system of claim 31, wherein the stacked microchannel heat exchanger is
2 thermally and operatively coupled to the IC die by a layer of solder disposed
3 between the stacked microchannel heat exchanger and the surface of the IC die.
- 1 35. The system of claim 31, wherein the stacked microchannel heat exchanger is
2 thermally and operatively coupled to the IC die by an adhesive disposed between
3 the stacked microchannel heat exchanger and the surface of the IC die.
- 1 36. The system of claim 31, wherein the stacked microchannel heat exchanger is
2 thermally coupled to the IC die by a thermal interface material (TIM) layer.
- 1 37. The system of claim 31, further comprising:
2 a solderable layer formed on the IC die, wherein the stacked microchannel
3 heat exchanger is operatively and thermally coupled to the IC die by the solderable
4 layer.
- 1 38. A system, comprising:
2 an integrated circuit (IC) package;
3 a stacked microchannel heat exchanger operatively and thermally coupled to
4 the IC die;
5 a pump, having an inlet and an outlet, said outlet fluidly coupled to an inlet
6 of the stacked microchannel heat exchanger; and
7 a heat rejecter, having an inlet fluidly coupled to an outlet of the stacked
8 microchannel heat exchanger and an outlet fluidly coupled to the inlet of the pump,
9 wherein the system employs a working fluid that transfers heat generated by the IC
10 die to the heat rejecter using a two-phase heat exchange mechanism.

- 1 39. The system of claim 38, wherein the working fluid is water.
- 1 40. The system of claim 38, wherein the pump comprises an electro osmotic
2 pump.
- 1 41. The system of claim 38, wherein the stacked microchannel heat exchanger is
2 thermally and operatively coupled to the IC package by a layer of solder disposed
3 between the stacked microchannel heat exchanger and the surface of the IC package.
- 1 42. The system of claim 38, wherein the stacked microchannel heat exchanger is
2 thermally and operatively coupled to the IC package by an adhesive disposed
3 between the stacked microchannel heat exchanger and the surface of the IC package.
- 1 43. The system of claim 38, wherein the stacked microchannel heat exchanger is
2 thermally coupled to the IC package by a thermal interface material (TIM) layer.
- 1 44. The system of claim 38, further comprising:
2 a solderable layer formed on the IC package, wherein the stacked
3 microchannel heat exchanger is operatively and thermally coupled to the IC package
4 by the solderable layer.
- 1 45. A system comprising:
2 an integrated circuit (IC) die;
3 a network interface;
4 an antenna coupled to the network interface;
5 a bus, said bus coupling the IC die to the network interface; and
6 a thermal mass coupled to the IC die, the thermal mass comprising a stacked
7 microchannel heat exchanger.

1 46. The system of claim 45, wherein the stacked microchannel heat exchanger is
2 thermally and operatively coupled to the IC die by a layer of solder disposed
3 between the stacked microchannel heat exchanger and the surface of the IC die.

1 47. The system of claim 45, wherein the stacked microchannel heat exchanger is
2 thermally and operatively coupled to the IC die by an adhesive disposed between
3 the stacked microchannel heat exchanger and the surface of the IC die.

1 48. The system of claim 45, wherein the stacked microchannel heat exchanger is
2 thermally coupled to the IC die by a thermal interface material (TIM) layer.

1 49. The system of claim 45, further comprising:
2 a solderable layer formed on the IC die, wherein the stacked microchannel
3 heat exchanger is operatively and thermally coupled to the IC die by the solderable
4 layer.

1 50. A system comprising:
2 an integrated circuit (IC) package;
3 a network interface;
4 an antenna coupled to the network interface;
5 a bus, said bus coupling the IC package to the network interface; and
6 a thermal mass coupled to the IC package, the thermal mass comprising a
7 stacked microchannel heat exchanger.

1 51. The system of claim 50, wherein the stacked microchannel heat exchanger is
2 thermally and operatively coupled to the IC package by a layer of solder disposed
3 between the stacked microchannel heat exchanger and the surface of the IC package.

1 52. The system of claim 50, wherein the stacked microchannel heat exchanger is
2 thermally and operatively coupled to the IC package by an adhesive disposed
3 between the stacked microchannel heat exchanger and the surface of the IC package.

1 53. The system of claim 50, wherein the stacked microchannel heat exchanger is
2 thermally coupled to the IC package by a thermal interface material (TIM) layer.

1 54. The system of claim 50, further comprising:
2 a solderable layer formed on the IC package, wherein the stacked
3 microchannel heat exchanger is operatively and thermally coupled to the IC package
4 by the solderable layer.

1 55. A method; comprising:
2 thermally coupling at least one stacked microchannel heat exchanger to at
3 least one IC;
4 passing a working fluid through the at least one stacked microchannel heat
5 exchanger;
6 transferring heat produced by the at least one IC via the at least one stacked
7 microchannel heat exchanger to the working fluid to convert a portion of the
8 working fluid passing through the microchannels in the at least one stacked
9 microchannel heat exchanger from a liquid to a vapor phase; and
10 passing the working fluid exiting the at least one stacked microchannel heat
11 exchanger through a heat rejecter, wherein the vapor phase portion of the working
12 fluid is converted back to a liquid phase.

1 56. The method of claim 55, wherein the at least one IC includes a processor IC
2 and at least one additional component from the following group: a platform chipset
3 IC, a video IC, a memory IC and a co-processor IC.

1 57. The method of claim 55, wherein the working fluid comprises water.

1 58. The method of claim 55, wherein the working fluid is passed through the at
2 least one stacked microchannel heat exchanger and heat rejecter via a electro-
3 osmotic pump.

1 59. The method of claim 55, wherein the heat rejecter comprises a channeled
2 heat sink including a plurality of hollow heat sink fins having respective channels
3 defined therein.

1 60. The method of claim 55, wherein the heat rejecter comprises a stacked
2 microchannel heat exchanger.